

Chapter 5. Education and Public Outreach

Education, Outreach, and the Public Mandate

*"You do not really understand something unless you can explain it to your grandmother."
—Albert Einstein*

The *Beyond Einstein* program offers an unparalleled opportunity to involve the public and the education communities in the excitement of cosmic exploration. Its major science themes are integrated into NASA's education priorities and goals. Its quest to investigate the Big Bang, matter and spacetime near black holes, and the expansion of the Universe will inspire the next generation of explorers, including students, educators, and the general public. In addition, the science and technology of these missions provide opportunities to cultivate the next generation of scientists and engineers. This latter goal, consistent with NASA's Education priorities, comes at a critical time, when the number of American-born scientists and engineers is dwindling. Further, the science and technology encompassed by these missions will lend themselves to providing educators with teaching tools to utilize in their science and math classes. The missions and research programs in *Beyond Einstein* will bring significant resources to this educational challenge, so that all Americans can share in the asking and answering of some of the most basic and far-reaching questions about the Universe. Finally, addressing questions about the origin of the Universe and the nature of black holes will engage the public in sharing in our exploration. The public's eagerness to share this adventure is reflected in part by the many Hollywood movies, television series, bestselling books, and popular articles that draw on the themes in *Beyond Einstein*.

The missions and probes in the *Beyond Einstein* theme offer unique educational opportunities. For example, the origin and nature of the Universe is considered an important part of science education and of cultural literacy generally. Students yearn for a deeper



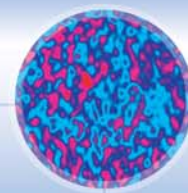
understanding of how the Universe originated. Current classroom materials developed for “Live from the Edge of Space and Time” help students explore the size and shape of the Universe and the nature of the expansion of the Universe. New results from MAP, LISA, and the Inflation Probe will extend this by developing a comprehensive and coordinated set of materials with which teachers and students can examine evidence for the Big Bang and trace the underlying idea that scientific inquiry can address even the most ancient and difficult questions. These are necessary topics for the education community as they are included in the *National Science Education Standards*, which also form the basis for most state education frameworks.

Similarly, black holes are a touchstone for a wide range of topics in the math and science curriculum, as well as inspiring great interest among students. *Beyond Einstein*’s quest to study matter and spacetime near a black hole provides opportunities to discover unexpected phenomena that occur in these extreme conditions. Black holes are cited in the *Benchmarks for Science Literacy*—published by the American Association for the Advancement of Science and widely used along with the *National Standards*—as an excellent way to introduce students to the important idea that “under extreme conditions the world may work in ways very different from our ordinary experience, and that the test of scientific theory is not how nearly it matches common sense, but how well it accounts for known observations and predicts new ones that hadn’t been expected.” The *Benchmarks* mandate that by the end of 12th grade, “students should know that . . . many predictions from Einstein’s theory of relativity have been confirmed on both atomic and astronomical scales. Still, the search continues for an even more powerful theory of the architecture of the Universe.” The very nature of *Beyond Einstein* provides the means for fulfilling these objectives.

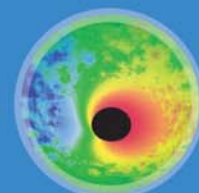
Another crucial area of opportunity is technology education. Many states now require technology education in middle school, and science museums across the country are building “Current Science and Technology Centers” to address the public’s interest in new technologies. The fantastic requirements of a mission like LISA—which will measure an object being jostled by less than the width of an atom—provoke the kind of excitement and questioning that draws young people into science and technology in the first place, as well as providing avenues for educators to bring concepts from engineering and technology into the classroom.

Current efforts in NASA’s Office of Space Science education program includes linking current space science content with education science content. It matches what scientists regard as fundamental results with the appropriate education curriculum in a manner that is more specific than those embodied in the standards. The missions of *Beyond Einstein* address the space science content in the origin of the Universe, black holes, binary systems, and endpoints of stellar evolution, among others, and thus through this concept map are readily linked to the education curriculum. In addition, these missions will be at the forefront of updating this science content, thereby impacting what is included in the science curriculum. Additional efforts in NASA’s Office of Space Science education program identify education science curriculum needs with available NASA education materials, thus allowing education and public outreach developers to identify where materials are needed. The *Beyond Einstein* missions will fill many of the needs for materials about the Big Bang, gravity, and the expansion of the Universe.

Among the hallmarks of *Beyond Einstein*’s approach to education and outreach are: the participation of space scientists at all levels of outreach; an emphasis on the diversity of people and cultures who contribute to the questions and the quest; an emphasis on professional development of pre-service and in-service teachers; the link between technology and the advancement of science; and an emphasis on the nature of scientific in-



big bang



black holes



dark energy

The show, Journey to the Edge of Space and Time, increased attendance at planetariums in Boston and Philadelphia by more than 20%.

The Starchild Web site for elementary students was one of the first winners of the Webby award for Education.

(<http://starchild.gsfc.nasa.gov>)

Imagine the Universe!, a Web site on Beyond Einstein themes, has been visited by millions of Americans.

(<http://imagine.gsfc.nasa.gov>)

"Thank you for such an educational site for children. I am a homeschooler and this is so comprehensive."
—Mrs. D.



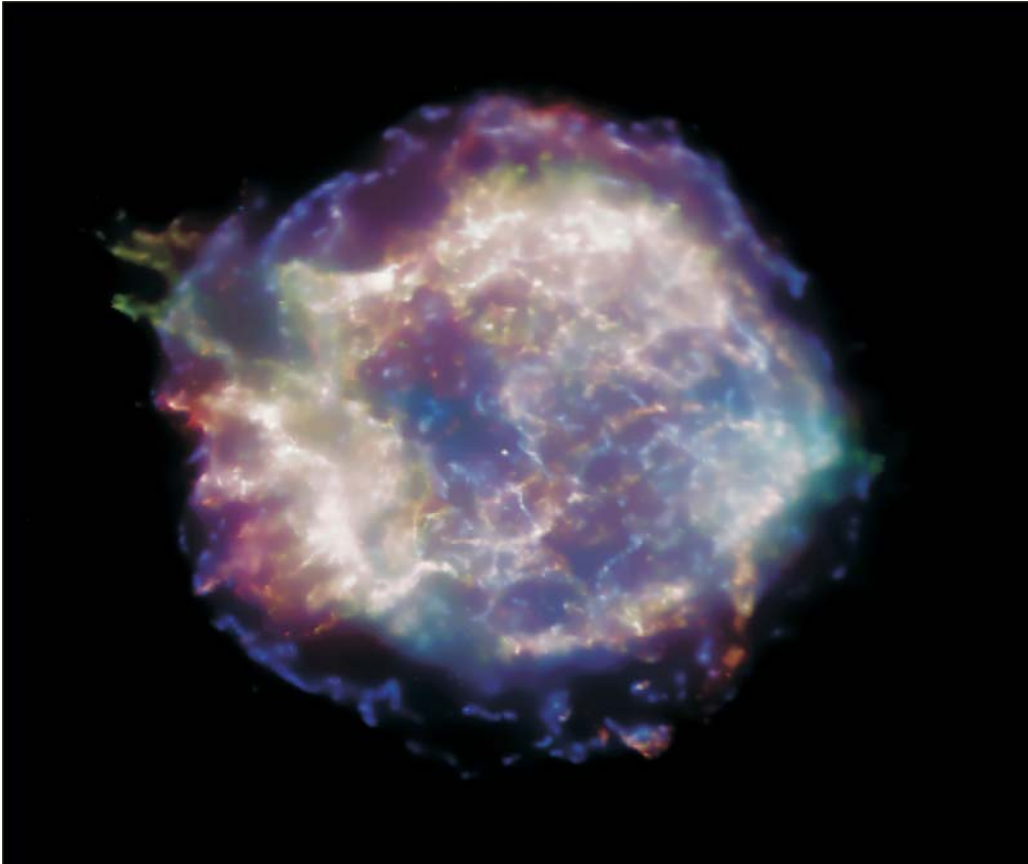
Studying the jet and accretion disk around a black hole.

quiry. Education and public outreach programs in the past have seen great success in telling the human side of planning, building, and launching the great missions of science exploration. The pioneering missions in *Beyond Einstein* offer opportunities to see the impact of dealing with profound questions on those who work toward the answers. Links to teachers will be established early in the *Beyond Einstein* program so that the educational component can grow with the program, and students, teachers, and the general public can participate in its thrill.

Beyond Einstein's education efforts are part of a comprehensive initiative coordinated by the Office of Space Science. Thanks to an efficient network of partnerships throughout the education and outreach communities, OSS products and programs now reach virtually every avenue of public interest, including the nation's schools, science museums and planetariums, media outlets, after-school programs, libraries, and community groups. Special emphasis is placed on the pre-college years, including middle-school and the lower grades, times when lifelong attitudes towards science and science literacy are developed. Outreach programs for the *Beyond Einstein* theme will build on these existing partnerships and programs.

Educational products and programs on the science themes of *Beyond Einstein* are expected to be extremely popular, as they have been in the past. For example, the television shows and educational materials for "Live from a Black Hole" and "Live from the Edge of Space," reached an estimated five million students. Either directly or indirectly, NASA materials related to the *Beyond Einstein* theme now provide much of, and soon the majority of, all materials on these subjects in our nation's schools.

Finally, *Beyond Einstein* missions will weave an ongoing story that is considered one of the most compelling in all science—a story that will form the raw material for museum exhibits, planetarium shows, radio programs, and other media outlets. We know that the public clamors to be involved in this story, because they vote with their feet and their pocketbooks: more than 120 million Americans visited science museums and planetariums in 2001—and the science themes included in *Beyond Einstein* remain favorites among museum goers.



Chandra X-ray Observatory image of the gas remnant of a supernova explosion, Cassiopeia A. Most of your body mass comes from elements created in stars; exploding stars like this one are the sources of the iron in your blood, the calcium in your bones, and the oxygen you breathe.